RESEARCH NOTE

EFFECTS OF CURRENT VELOCITY ON THE FRESHWATER BIVALVE *FUSCONAIA EBENA*

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ABSTRACT

As part of a research program on environmental effects of commercial navigation traffic, juvenile *Fusconaia ebena* (Lea) were exposed to three water velocity treatments in the laboratory. Changes in respiration rates and tissue condition were measured. Different experimental conditions were created by manipulating magnitude and duration of water velocities. Water flowed over gravel in which the mussels were positioned. The three treatments were: continuous-low (7 cm/s), continuous-high (27 cm/s), and cyclic-high water velocity which consisted of 5 min of high followed by 55 min of low velocity flow per hour. Tissue condition index (TCI, the ratio of tissue to shell dry mass) of *F. ebena* exposed to continuous-high turbulence was significantly less (0.05 level, Duncan's multiple range test) than TCI of mussels exposed to continuous-low or cyclic-high velocity. TCI of mussels in the latter two treatments did not significantly differ. There were no significant postimpact differences among respiration rates of mussels in the three treatments.

The passage of a commercial vessel through a waterway causes a brief change in water velocity that is usually accompanied by rapid drawdown and surge. Wuebben *et al.* (1984) reported a three-fold increase in bottom velocity and a 360° rotation in current direction immediately following commercial vessel passage in the St. Mary's River, Michigan, U. S. A. Eckblad (1981) determined that downbound tows in the upper Mississippi River caused current velocity to double. Concern has been expressed (e.g. Rasmussen, 1983) that this disruption in flow could negatively affect growth and survival of freshwater mussels (Unionaceae), a resource with commercial and ecological value. Typically, mussels inhabit channel border areas rather than main navigation channels (Coker *et al.,* 1921); however, physical effects of commercial traffic, while more severe in main channels, also take place in adjacent shallow water.

This note reports results of a laboratory study of the effects of exposure to continuous and cyclic periods of high water velocity on respiration and tissue condition of juvenile *Fusconaia ebena* (Lea), a thick-shelled unionid common in the lower Ohio River (Miller *et al.,* 1986).

METHODS

Seventy-two juvenile *Fusconaia ebena*, ranging in shell length from 17 to 26 mm were collected at Ohio River Mile 967, near Olmsted, Illinois, on 27 Aug 1985. The mussels were in a distinct mussel bed that supported a dense and diverse molluscan community (Miller *et al.,* 1986). Water depth where mussels were collected ranged from 3 to 5 m. River stage was near the average annual minimum at time of collection. Mussels were brought to the laboratory in Vicksburg, Mississippi, and gradually acclimated to aged dechlorinated tap water.

On 9 Sept, the 72 mussels were divided into three groups of approximately equal size distribution. Each group was exposed to one of three conditions: continuous-low, continuous-high, and cyclic-high water velocity. The experiment was conducted in three identical 200 *l* plexiglas chambers connected by a central mixing reservoir. The three conditions were created by manipulating the magnitude and duration of velocities of water flowing over gravel in which mussels were positioned (Table 1). Low-velocity flow (7 cm/s)

Table 1. Means and standard deviations of water velocity exposure, tissue condition index, and respiration rate measurements of juvenile *Fusconaia ebena* in three velocity exposure treatments. Mussels in the cyclic-high treatment were exposed to 5 minutes of high followed by 55 minutes of low velocity flow per hour. (Superscript letters a and b indicate which means were not significantly different at the 0.05 level using Duncan's Multiple Range Test; TDM, tissue dry mass; SDM, shell dry mass; percent reduction is relative to the tissue condition index of juvenile *F. ebena* fixed in the field upon collection on 27 August.)

	Velocity Exposure Treatment		
Variable	Continuous Low	Cyclic High	Continuous High
Water velocity (cm/s)			
Low	7.11 ± 1.02[a]	6.60 ± 1.02[a]	
High		26.42 ± 1.27[a]	27.18 ± 3.56[a]
Tissue Condition Index			
(TDM/SDM) x 100	1.72 ± 0.19[a]	1.69 ± 0.30[a]	1.43 ± 0.27[b]
Percent Reduction	19.73 ± 8.39[a]	22.39 ± 13.84[a]	34.48 ± 12.50[b]
Respiration Rate			
μmoles 02 / (mg x hr)	1.45 ± 0.27[a]	1.46 ± 0.55[a]	1.75 ± 0.58[a]

was created by continuous operation of a small centrifugal water pump submersed in each tank. A larger pump ran continuously in the continuous-high velocity treatment, creating a 27 cm/s flow. In the cyclic-high velocity treatment, the larger pump was activated for 5 min each hour with a programmable electronic timer. Water was maintained at 22 ± 5°C and contained an *ad libitum* but nonfouling suspension of brewer's yeast for the duration of the 37 day experiment. Nutritionally adequate feeding of filter-feeding bivalves in a small, closed system is difficult. The yeast suspension was provided for simplicity and because previous unpublished studies in our laboratory have shown that the yeast cells are ingested and used in partial support of maintenance metabolism.

On days 33, 35, and 37 eight mussels were removed from each of the three treatments to measure respiration and tissue condition. Respiration was measured by incubating each mussel in a 300 ml jar of water overnight in the dark at 22 ± 0.5°C. After incubation, a 60 ml aliquot was siphoned from each jar, and dissolved oxygen determinations were made on each aliquot by Winkler titration. Three blanks were tested with each batch to determine bacterial oxygen uptake. Following determination of respiration, soft tissue was removed from the shell, and all tissues and shells were dried for 48 hr at 65°C and separately weighed. A tissue condition index (TCI) was obtained by dividing tissue dry mass (TDM) by shell dry mass (SDM) (both in mg) and multiplying the quotient by 100. A batch of juveniles fixed in 12% neutral formalin upon collection of 27 August was treated in an identical manner to estimate initial TCI.

RESULTS AND DISCUSSION

The TCI of juvenile *Fusconaia ebena* in the continuous-low and cyclic-high velocity treatments was 20% and 22% less than the TCI of field-fixed juveniles. Continuous exposure to conditions in the high velocity water test tank caused a 34% reduction in TCI. Comparison of the mean TCI by Duncan's multiple range test indicated that weight loss was not significantly different ($p < 0.05$) between continuous-low and cyclic-high velocity treatments, but weight loss was significantly less in these two treatments than in the continuous-high velocity group (Table 1). Respiration rates, measured in still water, did not differ significantly among mussels from the three treatments.

Sustained changes in hydrologic conditions were known to affect pumping and filtration rates of marine lamellibranchs. These molluscs are sensitive to changes in flow (Kirby-Smith, 1972; Walne, 1972) and to small differences in pressure between the inhalent and exhalent siphons (Hildreth, 1976). In addition, differences in the shape of unionids can be attributed to hydrologic conditions (Van der Schalie, 1941; Clarke, 1982; and references cited therein). With respect to turbulence, Brown *et al.* (1938) observed that the degree of stunted growth in unionids from the western basin of Lake Erie was positively correlated to the extent of exposure to waves.

The present experiment demonstrated that juvenile *Fusconaia ebena* are not residually affected by 5 min exposure to high velocity flow once per hour in postimpact measurements. Commercial traffic rates in the upper Mississippi River and Ohio River do not often exceed one tow per hour (personal observations). Thus, turbulence caused by routine traffic is not likely to deleteriously affect mussels. Conversely, at sites where barges are fleeted, towboats sometimes work essentially continuously (personal observations). Potential impacts to mussels by abrupt water velocity changes in fleeting areas need to be evaluated on a site-specific basis.

Discharge of the lower Ohio River varies widely on a seasonal basis such that the range of water velocities experienced by mussels in the field is greater than the range between low and high flows used in the laboratory study. Parmalee (1967) reported that *Fusconaia ebena* inhabits sites with "swift current," although the population providing animals for the present experiment thrives in a slight current during normal summer and fall flows (Miller *et al.,* 1986).

The extent to which *F. ebena* is representative of growth and physiology of other unionids in large rivers has not been investigated. However, previous workers (Parmalee, 1967; Fuller, 1977; Buchanan, 1980) indicate that *F. ebena* was, and in many cases still is (Miller *et al.*, 1986), a major component of gravel bar communities in large waterways.

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